The Cornell Reading-Courses

LESSON FOR THE FARM HOME

L. H. Bailey, *Director*

Course for the Farm Home, Martha Van Rensselaer, *Supervisor*

VOL. II. No. 31 | ITHACA, N. Y. JANUARY 1, 1913 | SANITATION SERIES No. 2

HOUSEHOLD BACTERIOLOGY *

Martha Van Rensselaer

In the vegetable kingdom there are micro-organisms that are the smallest and simplest plants known. They live in soil and in water and are found on the surface of foodstuffs. Some varieties prey on man and beast and plant. They number hundreds of species, some of which are of great value in nature's economy and of great benefit to man, while others are sources of danger to the health of man and animal.

Dust is a conveyance of such micro-organisms. In itself dust is practically harmless, although it irritates the mucous membrane, scratches furniture, worries the housekeeper, and occupies space needed for something else. We cannot get rid of this old enemy; there will be dust as long as there are people and furnishings. Wind is an agent for distributing it. Housekeepers have probably always asked the question, "Where does all the dust come from?"

Fig. 24.— *Moving the dust and germs from one place to another*

THE DUST GARDEN

Let us have some dust gardens to study, and note what will be produced. A garden presupposes plant life. Every garden has weeds, as

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well as plants that we do not call weeds because they are being fostered. In the same way our microscopic dust-garden will have both non-useful and useful plants. In the ordinary garden, weeds that are visible may be destroyed with a rake or a hoe. In our dust garden are plants that are invisible to the naked eye, and the gardens in which they grow may be the food on our table, our own bodies, or the dust in our houses. These countless invisible living organisms affect us although we cannot see them. We ascribe the products of their activities to various causes. They are active and powerful in bringing about certain amazing transformations in matter, but we need more than the lens of the human eye to detect them. Since either good or harm may result from the presence of these invisible living individuals, we find that it is as desirable to cultivate some as to exclude others.

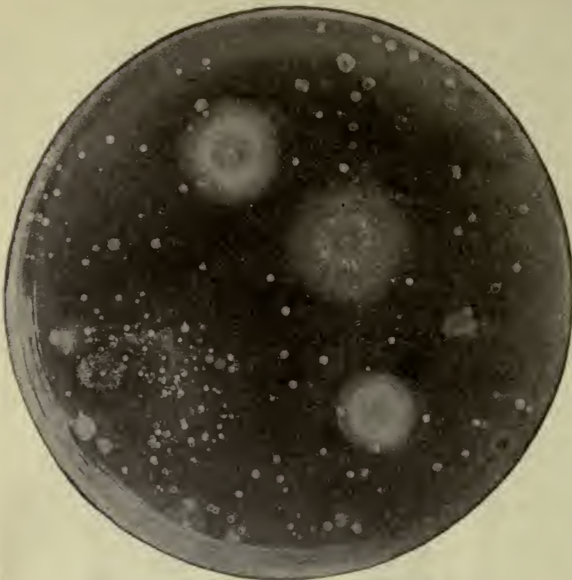

FIG. 25.— *What grew in a dust garden*

Glass boxes, fitted loosely with glass covers through which much that takes place inside may be seen, are shown in Figs. 25 and 26. One day these glass boxes served as garden beds.

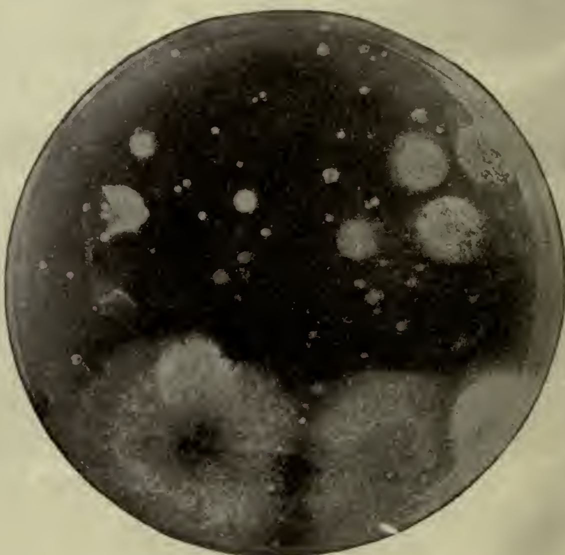

FIG. 26.— *Another dust garden*

SUPPLEMENT TO

The Cornell Reading-Courses

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L. H. BAILEY, *Director*

COURSE FOR THE FARM HOME, MARTHA VAN RENSSELAER, *Supervisor*

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HOUSEHOLD BACTERIOLOGY

DISCUSSION PAPER

This discussion paper, accompanying the lesson on Household Bacteriology, may be returned with answers to the questions and with any suggestions and questions of your own. While the answering of these questions is not absolutely necessary, a much greater benefit will be derived if you give to others the benefit of your own experience. It will also help us to understand your point of view. The lesson may be used in the grange and in the club where these subjects are considered.

1. The exposure to dust, in open store-windows and in wagons, of fruit and vegetables to be used later on the table is dangerous because the products collect on their surfaces germs that may be communicated to the consumer. Would it not encourage care on the part of the seller if housewives objected to purchasing such provisions? Discuss.

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2. How much does the effort to make clean, wholesome surroundings really add to the amount of work in the house?

3. What do you consider the most important ways in which you can apply the knowledge gained from the study of household bacteriology?

Name..............................

Address..............................

Date..............................

The soil used was a kind of beef-broth jelly. The seed was ordinary dust from an ordinary room. The boxes had been baked for over an hour in a very hot oven. The jelly had been steamed a number of times, until no living thing could possibly be therein.

A dust garden planted after a room had been carefully swept is shown in Fig. 25. When the cover of the box was removed and the dust raised by the broom into the air had settled on the soft, sticky jelly, something happened! In about twenty-four hours little specks appeared, which rapidly or slowly grew larger and developed various colors. Unfortunately, the photograph does not show the delicate greens, yellows, and blues of the different spots. As they grew larger some spots revealed a feathery or velvety surface and, like that at the left side, a dark center with dust flying from it. The other spots were shiny, wet, or waxy in appearance, and never showed any increase in height or any dark, dusty center.

Every housewife who has seen mold on her bread or on her jelly, in her pickle jar, or possibly on shoes and books, will suspect that the velvety, dark-centered spots are of similar nature. Molds spread their cells over the food, sending some cells down into the substance and others upward. From the tops of the upright cells grow others, and in or on them are formed thousands of dust-like specks, called spores. Each of these spores may start a new bed of mold. The infinitely tiny spores falling on soft substances, such as cheese or bread, send invisible lacy threads down into the substances; while on books, leather, wood, or cloth they may grow only over the surface and may remain invisible.

Certain spots in the dust garden are colonies of bacteria. Each spot shows where one plant or cell touched the jelly. This cell fed, and divided itself in the middle. These two cells repeated the process, until perhaps there were a hundred or more. Then a tiny speck became visible. No one ever saw, with the naked eye, a single bacterium or a mold spore.

In Fig. 26 is shown a dust garden with soil exactly like that of the one shown in Fig. 25, but the dust that planted it was thrown into the air by using a feather duster.

KINDS OF PLANT MICRO-ORGANISMS

Dust plants are micro-organisms. There are large numbers of minute organisms so small that they cannot be seen by the naked eye but require the aid of a powerful microscope to show their presence; hence their name, "micro-organisms." Various names have been given to these minute living bodies, such as "germs" and "microbes." Literally, germ means the beginning, the first living cell that produces a more complex form.

The plant micro-organisms that we shall consider are bacteria, molds, and yeasts.

Bacteria

Bacteria are carried on particles of dust, in liquids, and on the surface of fruits and vegetables as well as other articles of food exposed in the market. They may possibly find their way into the house by means of drains, and they are carried by insects. Normally, they are found in the air, in the soil, in water, in food, in the mouth and the digestive tract, on the skin, under the nails, in the hair, in the clothing.

Bacteria are reproduced by a process of division known as "fission," some of the different forms of which are shown in Fig. 27. The rapidity of reproduction depends on warmth, moisture, and food supply. Some species produce a new generation every half-hour; thus a single bacterium, if its growth were totally unchecked, might become in twelve hours an ancestor of sixteen million descendants. In two days the descendants

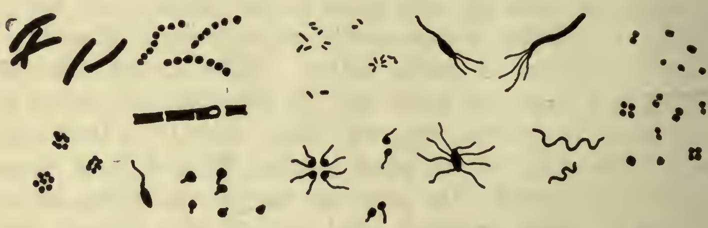

FIG. 27.— *Various forms of bacteria, or germs, showing different methods of fission. Greatly magnified*

would fill a pint measure. This rapidity of reproduction does not occur, because there are countless checks to the life of every species of bacteria.

We may form some idea of the minuteness of bacteria when we consider that the length of a single bacterium of some species is 1/25,000 of an inch. Many thousands of them may be packed into the space that a grain of sugar would occupy. If one falls into a minute wrinkle of the hand, it is as though it had fallen into a deep ditch.

Molds

Molds also are micro-organisms. A colony of mold organisms growing on some substance forms a velvety pile having a dark center. We often see long threads budding and branching to form a network over food. Each head produces thousands of dust-like spores. Some molds grow with less moisture than is required for bacteria, and some flourish in the light. They are frequently found in bread, on meat, on leather, and on sugary liquids. They increase very rapidly after rainstorms, and wind affects them less than it does bacteria.

Mildew is a form of mold found on moist clothes that have not been exposed to the fresh air. Mustiness is an indication of mold. Ringworm is due to this species of organism, which gets under the skin and causes inflammation.

Yeasts

The illustrations do not show a third kind of plant micro-organism which, especially in the country, is often present in house dust. That organism is yeast, which also is a single cell but which is reproduced by little buds that swell out from the parent cell and may or may not break off later. Those that float freely in the air, both inside and outside the house, are called "wild yeasts." So far as shape, size, and method of reproduction are concerned, these are little different from the cultivated yeast plants used to raise bread or to give the "sparkle" to sweet fermented liquids, such as beer.

As the invisible yeast plants can remain alive for a long time without moisture, we may have them furnished to us in dried cakes as well as in the fresh compressed form.

To-day, even with the cultivated yeasts, the housewife who mixes her sponge in a dusty room, in dusty utensils, with old yeast — or with everything clean and fresh, if she lets the sponge rise too long or keeps it too hot — is likely to have sour bread. Bacteria can grow well when and where yeast cannot, so that acid will be made from the alcohol that the yeast makes from sugar. The yeast plants grow best at a medium temperature, about 75° to 90° F., which is an average "summer heat." In a temperature above 90° F. yeast cannot grow so well, but bacteria grow better.

The little yeast plant, although so small and simple in structure, is endowed with many of the powers of trees and vegetables and other higher plants. It requires food, has a certain range of temperature in which it grows best, and is injured or killed by too high or too low temperature or by too little moisture. If it be given favorable conditions it will feed, grow rapidly, and reproduce itself by swelling out one part into a bud, which may or may not break away from the mother cell. The most favorable temperature for the rapid growth of the yeast plant, as already stated, is 75° to 90° F. Below that temperature the plant will not grow rapidly and therefore cannot do much work; at a temperature much above 90° it will be killed, and a dead plant cannot work any more than a dead animal can.

The work of the yeast plants is to change the sugar in bread sponge into two substances — alcohol, and a gas called carbon dioxid. The millions of little bubbles in the sponge cannot break through the sticky gluten

of the flour, so they raise the whole mass. When the bread is baked the gas is dissipated, the gluten walls of these bubbles are hardened, and little holes remain, filled with air only. The alcohol, too, is driven off by the heat.

It is very difficult to keep weeds out of the vegetable garden because their seeds are carried to the soil in many ways. When the weeds have sprouted or grown a little, they may be pulled up easily. In the bread-garden we want only yeast to grow, but it is very difficult to insure its growth alone since in the bread garden neither the good plants nor the weeds ever become visible. In no other way does household bacteriology interest the housekeeper so much as when connected with the baking of her bread.

Compressed yeast-cakes and dry yeast-cakes consist of a mass of yeast plants mixed with some form of starch and pressed into cakes. One yeast-cake may contain one half-billion yeast plants. It should contain only one species of yeast, but oftentimes other plants gain access to the mixture. If a compressed yeast-cake has been kept over a day or two it begins to turn dark and to soften. That is an indication that the yeast plants are dying and that bacteria have gained access to the cake, thus causing decay. The cake should then be discarded, for it will not make good bread. If dough is left too long or if it is kept too warm, the yeast plants become weakened; then the bacteria that may be present grow and produce an acid, making the bread sour. We scald the milk used in making bread in order to destroy the bacteria present. We bake bread for a full hour, or longer if the loaf is very large, in order to kill bacteria, yeasts, and molds, as all three may be present in a poorly baked loaf of bread and interfere not only with the keeping quality of the bread, but also with the health of the consumer. The careful housekeeper will have clean dishes in which to measure her ingredients and to mix her bread. She will not sweep nor cause a dust to rise in the room where she makes her bread, because bacteria are in that way raised into the air and may settle on her dough. She will cover the dough in order to keep out dust. With all her care there will always be some bacteria present, but they do not thrive in the sugar solution so well as healthy yeast plants do and at the temperature used for bread-making they do not grow so rapidly as do the yeast plants. They like the alcohol that the yeast makes from the sugar, however, so dough is kept at summer heat only long enough for the yeast to produce sufficient gas to raise the bread but not long enough for bacteria to get a start. It is better not to wrap cloth around hot bread just taken from the oven, because moisture and warmth favor the growth of bacteria and bread that is cooled slowly may not keep so well as if cooled more rapidly.

GERMS THAT ARE NOT HARMFUL

Some bacteria are of great value in the economy of nature. Man's bacterial friends have been found not less active than, and many times as numerous as, his bacterial foes. To his bacterial friends he owes the fertility of the soil by which plants are nourished. They tear down organic matter and pass it back to its simpler elements through the process of decay, thus ridding the earth of many harmful substances. This is the work of so-called nature's scavengers. There is advantage in what is called incipient decay. When bacteria grow in food the products of decomposition are different from the original nature of the food and produce new odors and tastes. We often need the flavors thus produced to stimulate the flow of the digestive juices. The gamy taste of meat is due to the beginning of decomposition of some of its constituents, and the strong flavor of limburger cheese is owing to the same cause. Gamy food, however, soon becomes objectionable; and cheese is ruined by the development of a too strong flavor of putrefaction.

The most common substances that owe their flavor largely to the presence of bacteria are butter, cheese, and vinegar. Without bacteria, butter, like "apple-pie without the cheese," lacks flavor; while cheese without bacteria would be like "the play 'Hamlet' with Hamlet left out"— an utter impossibility. When you next enjoy the acidity of a pickle, remember to give credit for that pleasant sourness to certain tiny plants, such as those that you have seen massed together in enormous quantities in "mother" of vinegar. Whenever a liquid containing a small amount of alcohol cider, for example, is exposed to the air, bacteria find therein a home and food. A film similar in nature to "mother" spreads over the top of the liquid and before long the alcohol becomes acetic acid, with vinegar as the result.

Our Puritan grandmothers would have thought us bewitched had we been able to tell them that their cheeses, on which they spent so many watchful hours, owed their making and their flavor largely to invisible plants. Even now scientists are unable to explain this process fully, although they are certain that there could be no cheese without bacteria.

From none of the harmless bacteria do we get more real enjoyment than from those found in butter. Long before the science of bacteriology and the days of cream separators, it was known that cream set to rise by its own lightness, skimmed, and left standing for several days would "ripen" and make far better butter than fresh cream. Butter made from ripened cream was found to taste better, keep better, and be made more easily than that made from unripened cream. We needed the bacteriologist to find the cause and to prove it to be the presence of bacteria; but long before his day the thrifty housewife had made use of the

principle involved, and had unknowingly availed herself of the assistance of the invisible plants.

The action of bacteria is very useful in the production of linen, jute, and hemp, in the tanning of leather, and in the maceration of skeletons. The destruction of garbage by means of the septic tank is owing to a certain class of bacteria.

METHODS OF DESTROYING THE EFFECTS OF BACTERIA

Heat

All bacteria are promptly killed by heat unless they are in the spore form or the resting stage. There are resting stages of some of these organisms when the conditions for active life are unfavorable. The organism itself may dry up and assume a dormant form, resuming its active form when favorable conditions recur; or it may throw off spores. Spores resist heat far better than does the active or vegetative organism; so, although we may have used enough heat to kill the active forms, we cannot be sure that we have destroyed all organisms unless we know that the particular organism which we seek to exterminate does not form spores or is not in the spore stage. Boiling for twenty minutes will generally, but not always, kill most forms of bacteria, including the spores. Water is pronounced safe when it is thus boiled. Mere simmering of water is not sufficient.

Fresh air and sunshine

Direct sunshine kills most bacteria. Many persons are afraid to take fresh air and sunshine in sufficient quantities to counteract the bad influence of dark rooms, moisture, and poor air; yet, of all the bactericides known there is none that compares in effectiveness with sunshine. Much suffering would be saved if persons could only be brought to a realization of this fact. Airing and ventilating bedrooms, kitchens, cellars, and stables aids much in keeping them wholesome.

Drying

About thirty per cent moisture is required for the growth of bacteria. This fact is the principle utilized in the preservation of many of our foods. In order to preserve seeds we dry them, and they do not begin to sprout until they are moistened when needed for planting. Flour is practically free from decomposition because it is dry, and a cracker keeps indefinitely for the same reason. In some regions, tons of fish are prepared for market by drying. Fruits, such as berries, raisins, apricots, currants, prunes, and apples, are preserved in this way. Dried beef has long been a familiar example of the application of this principle. It must be remembered

that drying only arrests the growth of bacteria, and that when food has over 30 per cent of moisture there is danger of its spoiling. Dried foods are therefore kept in a dry place so as to prevent absorption of moisture and consequent spoiling.

Cold-storage

As a means of preventing putrefaction and decay, storehouses are cooled artificially and a low and constant temperature is maintained. Eggs, fruit, vegetables, and the like may be kept for a considerable period of time if they are frozen, and may then be delivered at the market in fair condition for use. There is some question, however, regarding the safety of the use of cold-storage foods, for food deteriorates quickly if it is taken from cold-storage and not used immediately thereafter. As long as meats are kept frozen they may be preserved indefinitely. Ordinary ice-chests are very efficient for arresting the growth of bacteria, although the temperature in them is higher and less uniform than in cold-storage and they cannot be depended on for keeping foods for any length of time. Bacteria grow very slowly, however, in an ice-chest. The same statement is true regarding certain materials that have antiseptic power in a cool cellar.

Preservatives

Antiseptics are materials that retard or prevent the growth of bacteria. They may be used for the preservation of foods, but they should be harmless to man. Substances often used as preservatives are borax, boracic acid, salicylic acid, and formalin. In small quantities these preservatives have not been found to be very injurious; yet their use in manufactured foods has been made illegal in many States, as their presence in food might quickly lead to the consumption of amounts sufficient to be harmful. The housekeeper never knows how much preservative may have been used before articles of food come to her, hence it is safe for her never to use any preservative but to depend instead on the bactericidal action of heat. It is not known how much the digestive organs can endure from borax and similar materials, but experiments seem to show that such materials have a detrimental influence.

Harmless preservatives.— (a) *Sugar.* A heavy sugar solution prevents the growth of bacteria. In the proportion of 40 or 50 per cent, sugar makes an excellent preservative and is commonly used in this amount in the preparation of jellies, marmalades, and preserves and in preserving raisins, figs, and candied fruits. Condensed milk is also preserved by the addition of 30 or 40 per cent of sugar.

(b) *Salt* is very commonly used in the household to prevent bacterial growth. The housekeeper uses it for keeping fat pork, for corning beef and

bacon, for preserving eggs, hams, fish, and the like. Butter and cheese are salted partly for flavor, but largely for the sake of making them keep better.

(c) *Acids* protect food from bacteria and give a new flavor that many find acceptable. In making pickles we soak cucumbers in brine and add vinegar and spices to preserve them. The brine sometimes becomes covered with a scum, owing to bacterial growth, and the pickles grow soft through decay; these facts show that salt by itself is not a perfect preservative. The remedy in the case of the pickles is to scald them, in order to destroy micro-organisms. Other acids are known to preserve foods. This is the case with sauerkraut, which is protected from bacterial growth not only by acetic acid but also by lactic acid, produced by allowing bacteria to grow in the sauerkraut. The resulting acid finally destroys the organisms that have produced it, and aids in preventing the entrance of others.

(d) *Spices* are antiseptic and are added to foods in order to prevent putrefaction. Mincemeat is a good illustration of this practice. The apples and meat would putrefy very quickly were it not for the spices and boiled cider that are added to prevent putrefaction. We add sage and spices to sausage for the same purpose, while fruit cake is kept for a long time by the same means. Hops not only give a nutty flavor to bread and food in which they are used, but also have a slightly antiseptic action.

Canning

Canning keeps fruit and vegetables free from all bacterial growth because it first destroys all life present and then provides for complete exclusion of further organisms. As bacteria are found on utensils, in the air, and in water, and all food materials contain them, we first destroy the bacteria by boiling the food, and then seal the can, which has been thoroughly sterilized, in order to prevent the entrance of bacteria. The housekeeper has learned that a single bacterium in a can is sufficient to destroy the entire contents. Formerly she might have said, "I do not lose many cans of fruit in a year." With her present knowledge of the necessity for complete sterilization she may say, "I never lose a can of fruit."

This statement is made possible only by thorough sterilization and hermetic sealing of the receptacles used in canning. Some articles of food have to be cooked for a long time before becoming completely sterilized, because they contain spores that may resist ordinary boiling. Most failures in canning are owing to the use of insufficient heat or to failure to sterilize all the utensils used, thus leaving spores, which, developing later, will spoil the material canned. Spores get in accidentally. It is necessary

to prevent the raising of dust and to avoid the use of cloths or utensils not thoroughly cleansed. Persons will give themselves much concern in sterilizing fruit and jars, and then wipe out the clean jar with a dishcloth or let their fingers come in contact with the inside of the jar. Everything that comes in contact with fruit or receptacle should not only be clean but should also be sterile.

Cans must be sealed while still hot, so as to sterilize any air present. New rubber rings should be used each year, as they need to be soft and elastic, and they should be heated in water before being used. Sterilization can be accomplished much more thoroughly in factories than in private houses, because the former have equipment to produce sterilization under pressure. Never is the housekeeper more conscious of the necessity of exact laboratory principles than when she is canning her fruit; it is a piece of work of which to be proud, when she does it with the exactness of scientific principles.

DISEASE GERMS

A growing knowledge of bacteria has done much toward preserving or prolonging life. Some persons still state that they are happier if they do not know too much about germs. They affirm that before germs were known people were just as healthy as, and much happier in their ignorance than, at the present time. They confound knowledge with fear. Knowledge teaches prevention; fear preys on the mind. A lack of knowledge of how to avoid infection is inexcusable among the intelligent. An infected person should be isolated for the welfare of his fellow-beings, even though he is suffering merely from a cold. Every one now understands that a cold is contagious. With isolation to prevent others from becoming infected, and disinfection to kill already existent germs, sickness and the death rate would be soon and greatly reduced. A student who was interested in his work had mumps. He was asked by his instructor to remain away from class until he was well. On his refusing to do so, the dean of the college told him that he must leave the college until he was pronounced safe. The student said that he could not understand why he should not remain in the college because it was *his* mumps. The truth is that he could not keep his mumps to himself.

Some micro-organisms are parasites that produce disease. They feed on living plants and animals. Other micro-organisms live on both living and dead material. They are only partly parasitic and are capable of producing disease. Those microbes that cause disease are said to be "pathogenic." It is now known that microbes are the cause of many of the contagious or infectious diseases, such as tuberculosis, diphtheria, and typhoid fever. The better the conditions for the propagation of these

injurious germs if they should gain entrance, the greater is the danger of disease.

There is reason to hope that at no very distant day the spread of infectious diseases may be controlled, since it is generally known that there are specific living disease germs that pass from a patient to another person. If a person becomes infected with disease germs it is quite possible for him to pass on these germs to others through careless habits. Cases of sickness cared for at home — and this covers a large percentage of cases — make it necessary for the housekeeper to safeguard members of her family, as well as other persons, by a knowledge of bacteriology and a strenuous care to prevent infection. In the hospital such safeguarding is much more easily managed. Hospital methods, however, may extend to the home.

PRACTICAL APPLICATION OF PRINCIPLES OF BACTERIOLOGY

Thoughtfulness, together with a knowledge of the results of bad habits, brings many things to our notice to which we may have previously closed our eyes. We are prone to object to dirt without stopping to consider whether it is harmful dirt. Our housekeeping sensitiveness worries us if a neighbor calls and sees dust on the table. This dust may be less harmful, however, than a spoon dipped into the food that the cook is preparing for a meal, and then placed again in the food without being washed.

Kissing.— Kissing is a custom as old, probably, as the history of human beings, and no doubt to be continued but to be indulged in only when persons are in a healthy condition. Mothers are able to control the custom of kissing babies for a short period; they may lay a ban on the kissing of their infants by the admiring public. They should even control their own desire to kiss their children when affected with tuberculosis or suffering from tonsilitis or other inflammatory condition of the mouth or throat.

> " If a body meet a body
> Coming through the rye,
> Can't a body kiss a body
> For fear of bacilli?"

Care of finger nails.— We may wash our hands thoroughly, but underneath the nails may be dirt, difficult to reach, which is a retreat for germs. Clean finger nails are always an asset, but in the handling of food they are essential to safety.

Coughing and sneezing.— For coughing and sneezing " in the open " there is no excuse. A handkerchief should be within easy reach to catch the offending spray from the mouth and nostrils. The truth of this statement is an argument for a pocket in a woman's dress, in which to keep the handkerchief.

Handling of toilet articles.— The fingers of the attendant may after such handling unconsciously carry to the mouth infecting organisms.

Care of discharges.— Body discharges contain the seed, or germ, of disease. These should not be left carelessly, as in the case of sputum, to dry and be wafted about by the wind, nor thrown in a loose vault and allowed to reach the well or a body of water from which drinking water is obtained.

Insect pests.—The fly is no longer unpopular merely because of tradition and because of its annoying bites and specks, but also because of the now well-known fact that it carries disease germs on its feet and in its body. Mosquitoes, too, are in disgrace, for without them malaria would trouble no one.

Common drinking glass *Recently washed glass*

FIG. 28.— *Public drinking cups*

BY COURTESY OF MEDICAL REVIEW OF REVIEWS

Other animal disturbers.— Rats harbor the flea that spreads the germ of the bubonic plague. Cats and dogs are the delight of children and of many grown folks, nevertheless they sometimes bring with them germs of diphtheria, scarlet fever, and other diseases.

The common comb and brush.— Common toilet articles, unless thoroughly sterilized, are to be avoided in the barber shop, shampoo parlors, and even in the family, because dandruff and some other skin diseases are infectious.

The common cough-medicine bottle.— The medicine bottle may contain not only an opiate to paralyze the nerves, but also a cold-germ from the lips of the last patient who has placed the bottle to his lips.

The common drinking-cup.— Public sentiment has dealt a blow to the common drinking-cup. We never think in our homes of using the same

glass at table; yet at school, and in other public places, promiscuous drinking from a cup is still too common, although railroads are fast abolishing the common cup. Laws have been passed in some States forbidding its use in public places.

Railroad dust.— The railway porter's income is derived partly from fees for brushing the clothes of passengers. The dust from the clothing of one passenger is stirred up and settles on the plush seats of the car and on the clothing and persons of his fellow-passengers. Dust and money are thus put into circulation! Considering the danger from germ-laden dust, it is possible that the back platform might be less dangerous than the car aisle as a place for the brushing. A better way still is for every passenger to do his own brushing, in private, on his own back doorstep.

Food exposed to dust.— It may be difficult to cover all the left-overs and all the food in process of preparation; but the housekeeper is likely to attempt to do this when she realizes that the surfaces of uncovered food catch many flying particles and germs that we would rather not have made a part of our diet. Probably, if the bread had not been left unprotected, the mouse would not have jumped into it. We can see the mouse, however, in time to avoid making him a part of our meal, whereas the obnoxious germ is so small as to escape notice. A table filled with left-overs, waiting to be prepared for the next meal, is a veritable dust-garden, and who knows what additions it may make to our diet? Of course, sufficient heat applied may kill anything dangerous, but we do not want dirt in our food even though the germs have been killed.

Food exposed in the market.— Housekeepers are promoting the interests of health when they buy only those foodstuffs that are protected, on wagons and in the market, from the dust of the street. Handling foods with clean hands necessitates in the grocery a place in which the hands can be washed frequently.

Washing clothes without boiling.— There are pieces in the laundry that should be boiled; handkerchiefs, bed linen, underclothing, and, in fact, all clothing are the better for sterilization. The newer methods of cleaning and pressing woolen suits are good from a sanitary standpoint. Cleaning processes involve steam, which is a sterilizer, and often gasoline, which is a partial disinfectant.

Tainted money.— No one refuses even a grimy, dirty bank-bill, but every one feels the need of washing the hands after handling it. Placing coins in the teeth shows decided lack of intelligence or reckless disregard of sanitary principles. The coins that pass through many hands may have become infected with the micro-organisms of diphtheria, tuberculosis, or other specific diseases.

Care of toilets.— Public and private toilets should be disinfected very frequently. The basin, bath, and the seat especially, need careful washing with a disinfecting solution. Cloths and brushes used about the toilet should be scalded and not used for other purposes of cleaning.*

Careless dishwashing.— The thorough washing of pans, kettles, and cans makes housework and cooking far from easy, but in the long run it is easier than caring for sickness or being disabled. It is not so difficult to do the cooking when some one else does the cleaning up. The fewer the creases in a cooking utensil and the more it is scalded, the better. Sun and hot water are most beneficial agents for the safe care of kitchen utensils.

The refrigerator.— The refrigerator might be called on to tell many tales of the life history of germs, for its recesses hide a multitude of secrets. Slime left where the ice has melted shows the need of care in cleaning the refrigerator, for here is food for bacterial life. The spilling of food on the shelves is another source of the same trouble. Ice should be well washed before being placed in the refrigerator. All bits of food should be removed from the shelves and crevices, the refrigerator should be often washed and scalded, and some antiseptic, such as washing-soda, should be used. The chill of the refrigerator retards the growth of micro-organisms, but probably does not destroy them.

BACTERIA AND MILK

As milk is one of the most important foodstuffs, especially for children, it is very important that every housewife should understand something of the effect of bacteria on it. Every one knows that milk contains a certain number of bacteria. Some of the germs are in the udder itself, but most of them get into milk after it is drawn. Dirty cows, dirty barns and stables, dirty hands and clothes of the milker, and dirty utensils all contribute to increase the number of germs in milk. If the milk is not properly cooled and kept cold, bacteria multiply and produce many changes in it which often trouble nurse and cook.

The most common of the difficulties encountered in caring for milk is the simple souring, or lactic-acid fermentation. In addition to this well-known process, there are a number of other and more troublesome changes, such as the appearing of bitter milk, slimy milk, and tainted milk.

The lactic fermentation, or common "souring," of milk is brought about by a number of species of bacteria. Formerly it was supposed that a single species produced this change, which consists in the splitting of the milk-sugar molecule into carbon dioxid and lactic acid. It is

* A lesson on disinfection is in preparation.

now known, however, that in the process of splitting up the milk-sugar other by-products are produced. In the simple lactic type of fermentation these secondary products are not very important. It should be noted, however, that in the souring of milk by different species of bacteria, correspondingly different by-products may result. In consequence of this the souring is often accompanied with by-products that are undesirable, if not injurious, to the consumer. In such cases the deleterious substances are often produced before the quantity of acid is sufficient to cause curdling. In fact, the by-products themselves may become harmful while the milk is still considered sweet and wholesome. The most telling truth that comes to us from all inquiries on the subject is, that different bacteria causing souring in milk produce very different effects on the milk itself, as is shown in the rapidity of the souring and in the types of fermentation accompanying it.

Much has been written concerning disease-producing bacteria in milk. They belong to two distinct classes, namely: (1) The specific bacteria of certain diseases of cattle, which may, if the animal is suffering from disease, gain entrance to the milk. In this class may be mentioned tuberculosis, foot-and-mouth disease, and possibly anthrax. (2) The bacteria of certain human diseases, such as typhoid fever and diphtheria, and the virus of scarlatina and measles. A large number of epidemics of these diseases has been traced to the milk supply; through it the infections occurred. The explanation of this is, that in cases in which the diseases existed among the attendants or in their homes, sufficient care was not taken in handling milk to prevent the entrance of the disease germs. In the case of typhoid fever the water used in rinsing utensils may be contaminated. In cases of diphtheria it often happens that those who have recently apparently recovered from the disease but still have the bacilli in their throats, are engaged in milking or in otherwise handling the milk, when, by sneezing or coughing, the bacilli from the throat may be introduced into the milk. The sad experiences of the past are teaching the importance of taking reasonable precautions against such infection.

When digestive disorders, especially among children, follow the use of milk containing many bacteria, the immediate cause is quite as likely to be the acids and other by-products that have been produced in the milk by various forms of bacteria, as the activities within the digestive tract of any one or more species of the micro-organisms consumed. We must look to the effect of bacteria on the milk itself for the cause of many, but not all, of such ailments. It is to prevent those effects that pasteurization is employed.

Milk is sterilized or pasteurized for two purposes: to keep it sweet for a longer time than would otherwise be possible, and to kill all harmful

bacteria that it may contain. *Sterilizing milk means boiling it for a certain length of time*, or heating it nearly to the boiling point, allowing it to stand for some hours and again heating, repeating the operation several times. Boiled milk is very difficult for children to digest. *Pasteurization* is accomplished by bringing milk to a temperature of 60° to 65° C. (140° to 149° F.) and holding it there for twenty minutes, after which it is cooled quickly. This process does not affect the taste of the milk, and such milk is more readily digested than is boiled milk. We should not need to depend on sterilizing or pasteurizing as a means for providing germ-free milk. The milk should be produced in a clean manner, for clean raw milk is more wholesome for children than cooked milk, no matter what the method of cooking may be. Hot air and steam are valued germicidal agents; hence their wise use in the dairy.

The cow not only needs wholesome food, but also needs to be kept clean. From the time the milk leaves the udder there is danger of its contamination.

Look first on this picture: A milkman dressed in clothes brushed clean, his hands washed in soap and water, not simply rinsed at the trough, his finger nails short and clean; the cow curried, her udder washed; the pail to be used covered until needed for the milk; the stable clear of dirt. Look next on this picture: The cow lying in her own dirt overnight, her udder soiled; the milkman dressed as he has been while doing all sorts of work; the cow's tail switching and dirt flying; flies bothering the cow until she kicks — if not into the pail it is only careful management that has prevented such an occurrence. Milk produced in the latter way is hardly worth buying; while for that bought from the former milkman we can afford to pay a good price — enough to encourage a man to keep clean and to have clean stables and cows. Pay enough to allow the farmer to have cement floors, tight ceilings, good ventilating devices, and general cleanliness. Then he will scrub his floors and will hang up his milking suit, to be used only while milking.

"We always strain our milk, and dirt and hairs are removed from it," say some. Yes, but we do not like to eat bread that the mouse ran over, even if the mouse has gone. A good part of the dirt that may get into milk is soluble and cannot be strained out. A diseased cow! We think it not profitable to throw away milk, but consider the danger to human beings of infection from the use of impure milk! It is safe to watch the cow, so as not to use the milk from a cow that is diseased.

The milk that a certain housekeeper was buying appeared at one time to be not quite right, and she interviewed her milkman. "Many hairs and much dirt in the milk," was her complaint. "Oh well," he said, "I have to hire my milking done and you know how it is, they won't

always be careful; I have told the man if the cow stepped into the pail to throw the milk away, but he won't always do it unless he is watched."

Tests were made some years ago by R. A. Pearson, at that time Professor of Dairy Industry at the New York State College of Agriculture, and by Walter E. King of the State Veterinary College, in order to determine the importance of different sources of milk contamination. Mr. Pearson has given the following as a result of these experiments:

" In most of these tests, a definite quantity of sterilized milk at 98° F. was exposed to some one kind of contamination that we wished to test. The milk was then examined and in that way we could get a fairly accurate idea of what this particular kind of contamination amounted to. Some of the experiments and their results are as follows:

1. " *Exposure to air in the stable.*— Two liters (about two quarts) of sterilized milk were placed in a sterile pail and exposed seven minutes to the stable air in a passageway behind the cows. This stable was doubtless cleaner than the average and the air contained less dust than is often found in places where milk is being handled. Immediately after this exposure, the milk was 'plated' and found to contain 2,800 bacteria per cubic centimeter (about fifteen drops); in other words, between 5,000,000 and 6,000,000 bacteria had fallen into the two liters of milk in this short time.

2. " *Pouring milk.*— When milk is poured from one vessel to another, a very large surface is exposed to the air and great numbers of bacteria are swallowed up. The following tests illustrate this point: About five liters of milk were poured from one can to another eight times in the stable air. It was found, after pouring, that this milk contained practically 100 bacteria per cubic centimeter more than it contained before pouring; in other words, about 600,000 bacteria had got into the milk because of this exposure. In another similar experiment, when there was a little more dust in the air, the contamination due to pouring eight times was two and one half times greater than in the preceding experiment.

" The importance of pouring milk as little as possible from one vessel to another has suggested to Dr. J. Roby, of the Rochester Health Department, that milking-pails should be made larger than those now used and immediately closed after the cow has been milked. The milk should then be cooled and delivered in these same pails without further exposure. In some ways this suggestion is a most excellent one, but it may be that under certain conditions the disadvantages of this method of handling milk would exceed the advantages.

3. " *Contaminated utensils.*— Much contamination of milk results from putting it into dishes that have been cleaned and then exposed where dust can fall into them. In experiments to determine what this kind of

contamination amounts to, it has been found that when little care is taken to protect the dishes, the milk will often contain several hundred times as many bacteria as when the utensils were protected from dust. In order to illustrate this point, two pails were carefully washed and sterilized. One of them was covered with sterile cloth to keep dust from falling into it. The other was left exposed to the air of a clean creamery for only a few minutes. A small quantity of sterile milk was then put into each pail, rinsed around, and then examined for numbers of bacteria. It was found that the milk in the pail which was not protected from dust contained 1,600 more bacteria per cubic centimeter than the milk in the protected pail.

4. "*Contamination from the cow's udder and body.*— Great numbers of bacteria fall into the milk when it is being drawn from the udder, because the milking pail is directly under the udder which is being shaken more or less by the milker's hands. This kind of contamination may be reduced by cleaning the udder. It was found that sterile milk exposed under the udder as long as it takes to milk a cow, and while the udder was being shaken about the same as when milk is being drawn, contained 19,000 bacteria per cubic centimeter. In this case the udder had been wiped off with a dry cloth much in the same way as is done in fairly good dairies.

"In a similar test, the udder was wiped with a damp cloth and then the number of bacteria was reduced to 4,500 per cubic centimeter. In a third experiment the udder was wiped with a cloth dampened in a 4-per-cent carbolic acid solution; then the number of bacteria was 3,200 per cubic centimeter. In cases in which no particular care is taken to clean the udder, the bacteria getting into the milk from this source may run up into the hundreds of thousands or millions.

5. "*Importance of small openings in milk pails.*— Thus it is seen that it is impracticable to clean the udder or free the air from dust so perfectly that *no* bacteria will fall into the milk. The next question is, how can we reduce the number of those that will fall in spite of all reasonable precautions? The easiest way known is to use a small-top milking-pail. Reduce the opening through which dirt can fall into the pail. An experiment was conducted to illustrate this point, and it was found that milk drawn in an ordinary milking-pail contained 1,300 bacteria per cubic centimeter, while that drawn in a pail with opening about one half as wide contained only 320 bacteria per cubic centimeter. This is just what we would expect when we compute the number of square inches through which dust can fall into the different kinds of pails. For example, a pail having a top 14 inches in diameter has an opening of 153.86

square inches; a pail with 12-inch top has an opening of 113.04 sq[u]
inches; one with 10-inch top has an opening of 79.79 square inches; a

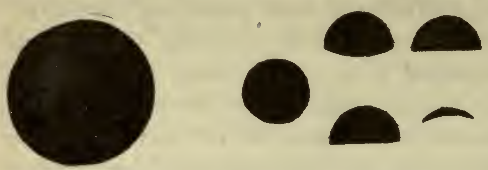

FIG. 29.— *Diagram showing size of openings in various kinds of milk pails. The large circle at the left represents the common milk pail. The others show the perpendicular exposure in the new kinds of pails*

with an opening of 6 in[c] in diameter has an expo[s] of 28.26 square inches.

"Milkers should get i[n] the habit of using the sm[all] top pail, as it is one of [the] easiest of all ways for re[duc]ing the number of bact[eria] that fall into milk.

6. "*Contamination by flie[s]*
A fly or a bit of hay or straw or a piece of sawdust or a small hair, [m]
carry enormous numbers of bacteria into milk as is shown by the foll[ow]ing experiments:

"A living fly was introduced into 500 cubic centimeters of sterile m[ilk]. The milk was shaken one minute and then it contained 42 bacteria [per] cubic centimeter. After 24 hours at room temperature, it contai[ned] 765,000 bacteria per cubic centimeter, and after 26 hours 5,675,000.

7. "*Dirt in the milk.*— A piece of hay about two inches long was pla[ced] in 500 cubic centimeters of sterile milk. The milk was shaken one min[ute] and it then contained 3,025 bacteria per cubic centimeter. After 24 h[ours] at room temperature it contained 3,412,500 bacteria per cubic centime[ter].

"One piece of sawdust from the stable floor was put into 500 cu[bic] centimeters of sterile milk. The milk was shaken one minute and [the] bacterial content was then found to be 4,080 per cubic centimeter. A[fter] 24 hours at room temperature it was 7,000,000 per cubic centimeter.

"A hair from a cow's flank was put into 500 cubic centimeters of ste[rile] milk. After shaking the milk for one minute it contained 52 bacteria [per] cubic centimeter. After 24 hours at room temperature it contained 55,[...] per cubic centimeter, and after 36 hours over 5,000,000 bacteria per cu[bic] centimeter."

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